Reservoir Gases Exhibit Subtle Differences

Part 4: This segment of the reservoir fluids series describes the characteristics of wet and dry gases. At an initial producing gas-oil ratio greater than 15,000 scf/STB, engineers can treat the reservoir fluid as a wet gas. Gases with initial producing gas-oil ratios greater than 100,000 scf/STB can be treated as dry gases.

Retrograde behavior has been observed in gases with initial producing gas-oil ratios greater than 150,000 scf/STB.[1] The quantity of retrograde liquid in the reservoir is very small for gases this lean. If a gas has enough heavy components to release condensate at the surface, the gas will probably release some amount of condensate in the reservoir. This implies few true wet gases exist (liquid at the surface but no liquid in the reservoir).[1]

However, the concept of a wet gas is very useful for engineering purposes. The gas material balance equation can be applied for a wet gas by simply combining the surface gas and condensate by calculation to determine the properties of the reservoir gas, and adding the gaseous equivalent of the surface condensate to the surface gas production.[2] If there is a stock tank gas, its specific gravity (which will be relatively high) must be included with the specific gravity of the separator gas or gases (weighted by gas production rates) to obtain an estimate of surface gas specific gravity. If the gas production rate and specific gravity of the stock tank vent gas are not known, a correlation is available.[2]

The problem is determining a value of initial producing gas-oil ratio above which an engineer can assume that the wet gas procedures are applicable.

Fig. 1 shows the relationship between normal gas z-factors and two-phase z-factors.[3] The data were taken from a retrograde gas laboratory report. Gas z-factors approach a value of 1.0 at low pressures. Two-phase z-factors tend to continue decreasing at low pressures due to the presence of the liquid phase. However, sometimes the two-phase z-factors tend toward a value of 1.0 at low pressures, indicating the fluid acts like a single-phase gas (i.e., acted like a wet gas) even though two phases are present.

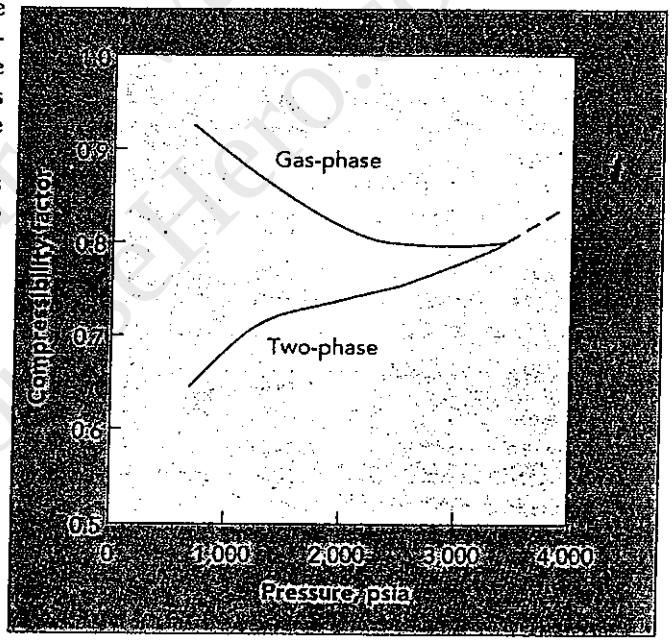

Fig. 1. At lower pressures, gas z-factors approach a compressibility factor of 1.0. The pressure of a liquid phase causes two-phase z-factors to decrease at low pressures. Occasionally, two-phase z-factors approach 1.0 at low pressure, indicating fluids that act like a single-phase gas.

Data from 131 laboratory studies of retrograde gases were partitioned into those for which the two-phase z-factors decreased at low pressures and those that had two-phase z-factors tending toward 1.0 at low pressures.[3] Fig. 2a shows two-phase z-factors for those retrograde gases which have heptanes plus concentrations greater than 4 mole %. Fig. 2b gives two-phase z-factors for those retrograde gases which have heptanes plus concentrations less than 4

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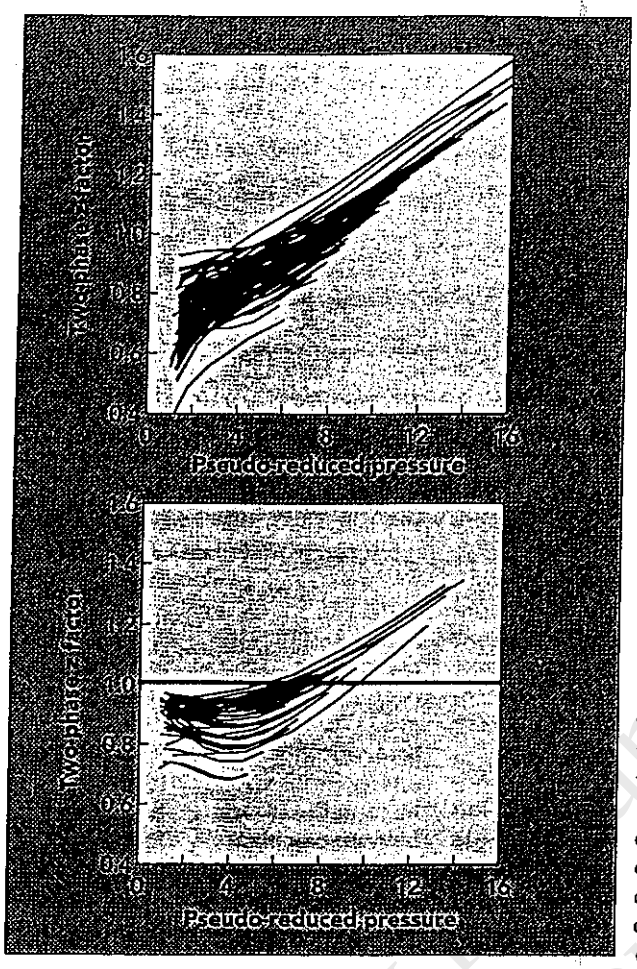

In Fig. 2a, laboratory studies reveal that retrograde gases with heptanes plus concentrations greater than 4 mole % generally have two-phase z-factors which decrease at low pressures. In Fig. 2b, heptanes plus concentrations less than 4 mole % generally have two-phase z-factors that approach 1.0 at low pressures.

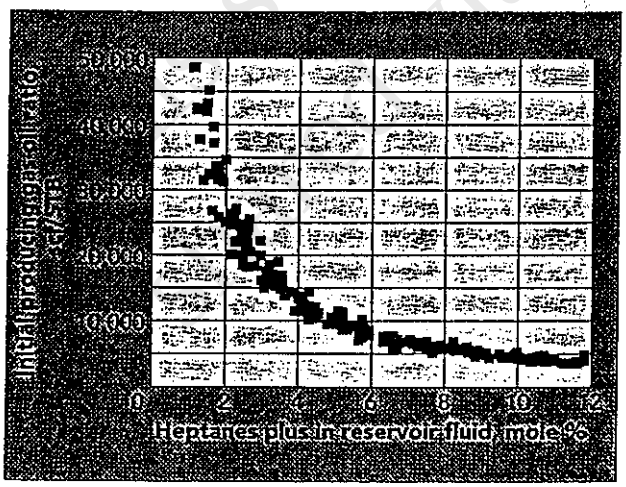

Fig. 3. When the heptanes plus concentration is less than 4 mole %, the initial producing gas-oil ratio will be greater that 15,000 scf/STB, and the fluids can be treated as wet gases.

mole %. Apparently, if the concentration of heptanes plus is less than 4 mole %, the gas can be treated as if it were a wet gas even though the laboratory reported the presence of some retrograde liquid.

Fig. 3 is part of a data set discussed in Part 1 of this series.[1] The heptanes plus concentration of the gas is expected be less than 4 mole % when the initial producing gas-oil ratio is above 15,000 scf/STB. Thus, if the initial producing gas-oil ratio is above 15,000 scf/STB, the reservoir, fluid can be treated as if it were a wet gas.

The effects of condensate volume on reservoir gas specific gravity and cumulative gas production are insignificant when the yield of condensate is 10 bbl/MMscf or less (i.e., when the initial producing gas-oil ratio is 100,000 scf/STB or more). Even though some condensate is produced to the surface and possibly some retrograde condensate is formed in the reservoir, reservoir fluids with initial producing gas-oil ratios this high can be treated as dry gases. The surface gas specific gravity can be used to represent the specific gravity of the reservoir gas, and the surface gas production rates can be equated to reservoir production rates. ●

Author's Note

The previous articles in this series have detailed the differences between pairs of reservoir fluids. Next month, Part 5 will compare the details among all five reservoir fluids.

References

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